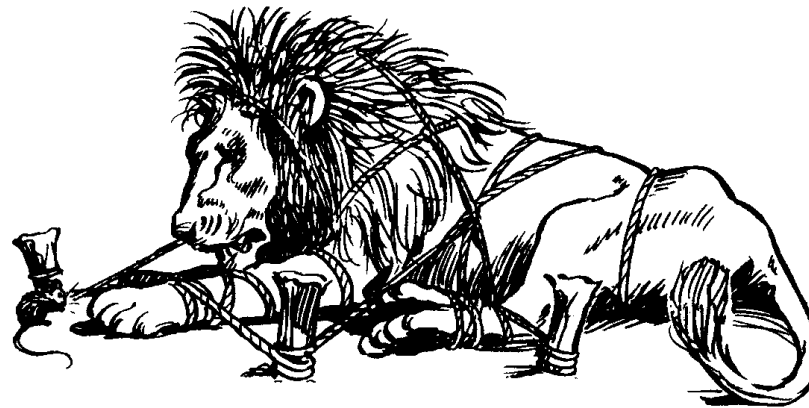


Exceptional service in the national interest



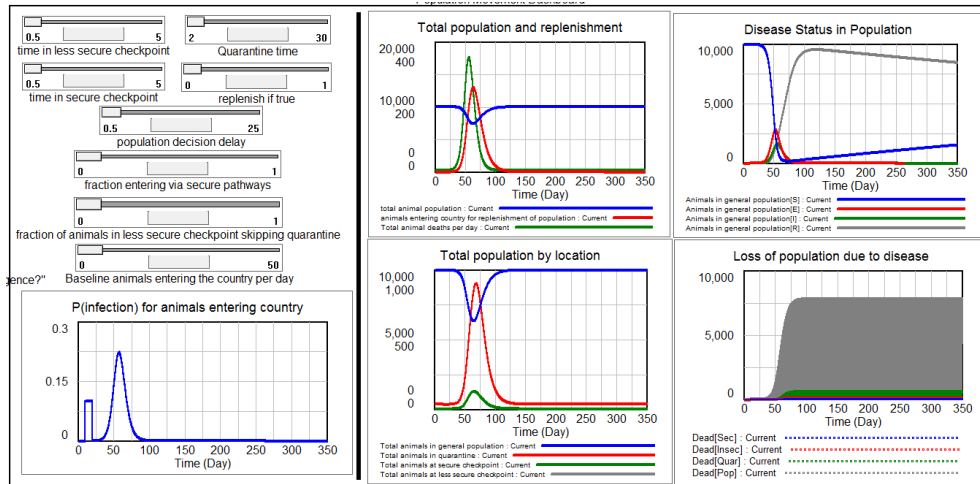
Interactive Storytelling Using SD Models

Bobby Jeffers

A large portion of a model's usefulness comes from its ability to provide understanding and insight to the right people



But often the "right people" are not modelers themselves



What is the next best thing to immersing oneself in the model?

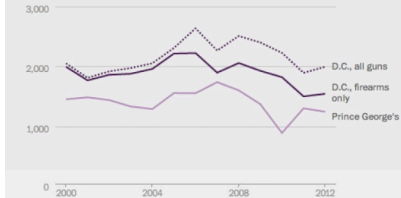
Storytelling...with data!



Breaking down the guns seized by police

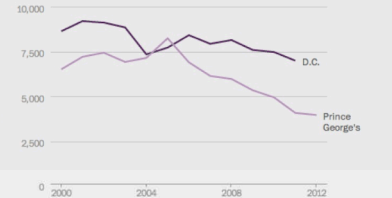
TOTAL GUNS COLLECTED

From 2000 through 2012, law enforcement recovered more than 28,000 guns in the District and nearly 19,000 guns in Prince George's County. D.C. includes non-firearms such as BB guns; Prince George's does not.



VIOLENT CRIME SINCE 2000

While the number of guns recovered annually has slightly decreased, violent crime has dropped at a greater pace — down 19 percent in D.C. and 37 percent in Prince George's — since 2000.



BREAKDOWN OF RECOVERED FIREARMS

These percentages do not include nearly 3,400 air guns — weapons not considered a firearm under federal law — that were collected by D.C. police and sent to firearms examiners who then logged the guns into a database. In Prince George's County, these types of guns are not included in gun recovery logs.



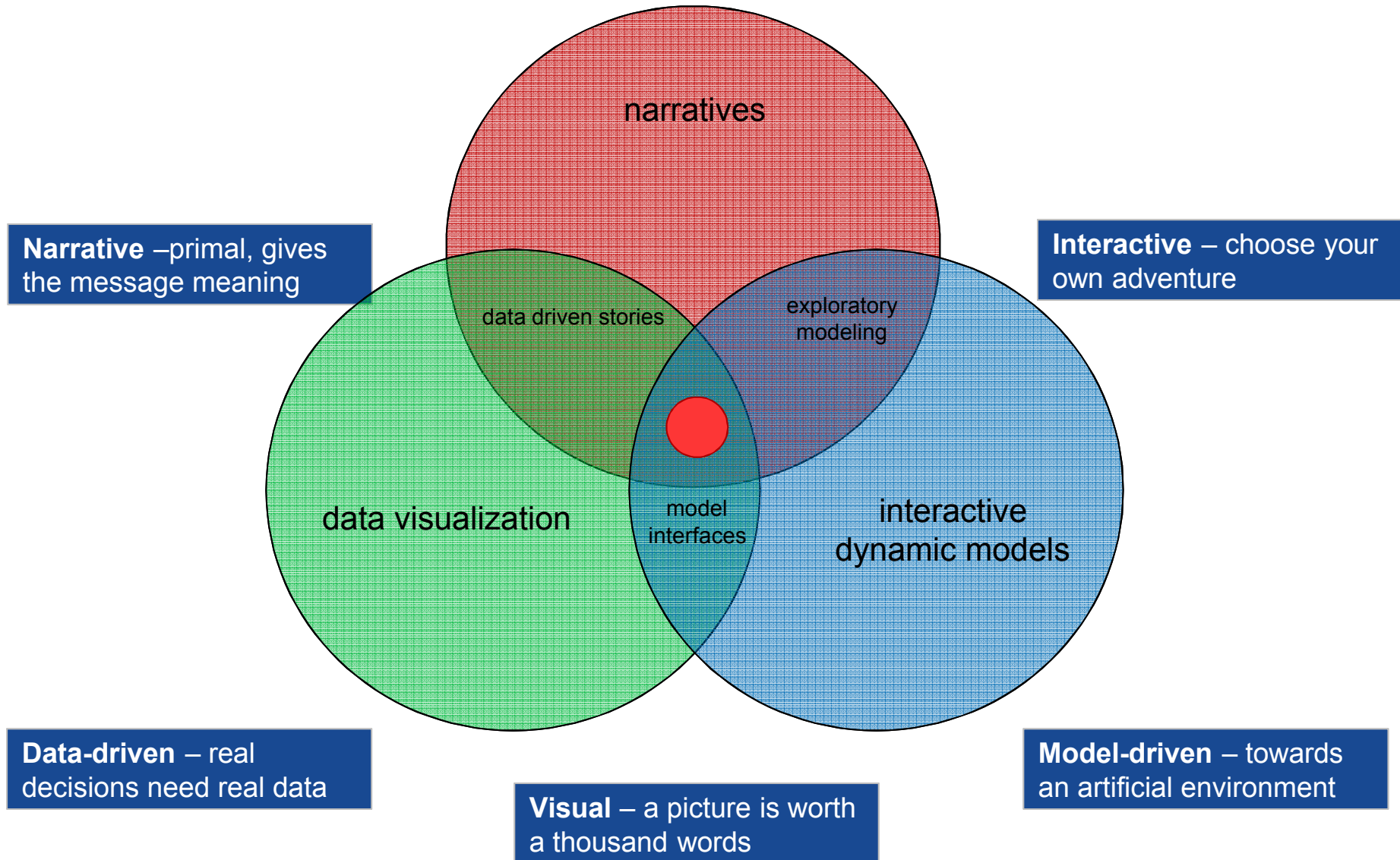
How guns were recovered



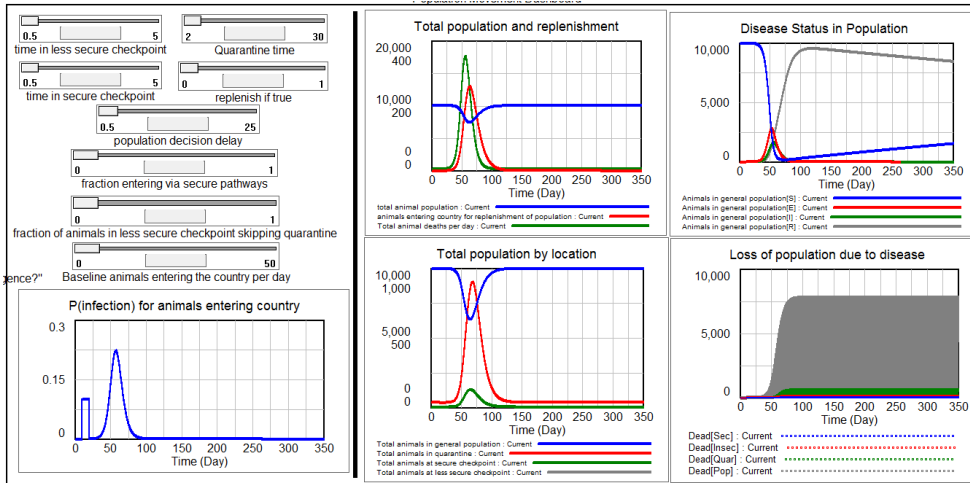
About this data

This report is based on data for nearly 47,000 guns seized or recovered by police and submitted to the firearms examination units in the District and Prince George's County from 2000 through early 2013. Totals include some guns from other regional law enforcement agencies, as well as guns taken in amnesty or buy-back programs, and some air-powered guns or other replicas. Some recovery locations could not be mapped. Details about each gun vary, depending on the jurisdiction and the information supplied by the officer who recovered the gun.

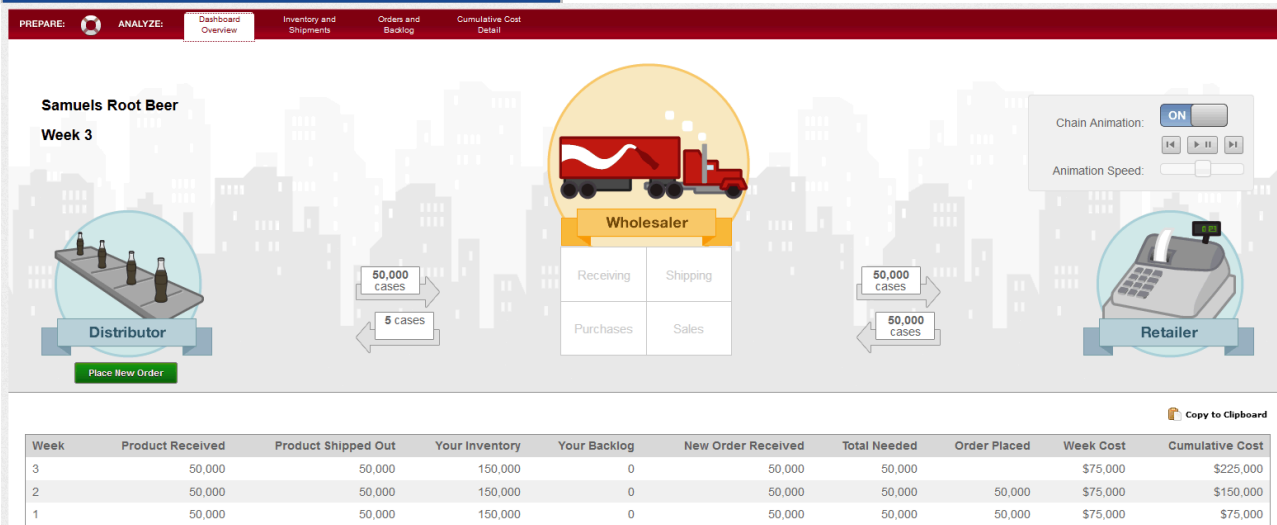
Aspects of storytelling



Vensim, Powersim Studio, Ithink/Stella



Forio



Tools for interactive storytelling

Tableau

Sandia National Laboratories Mississippi River Commodity Explorer, BETA 0.1..

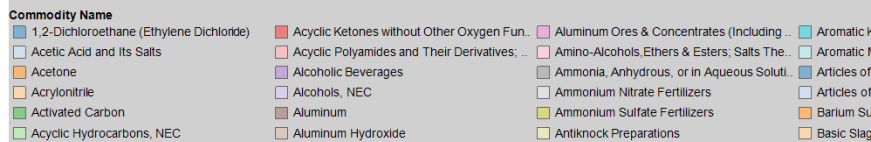
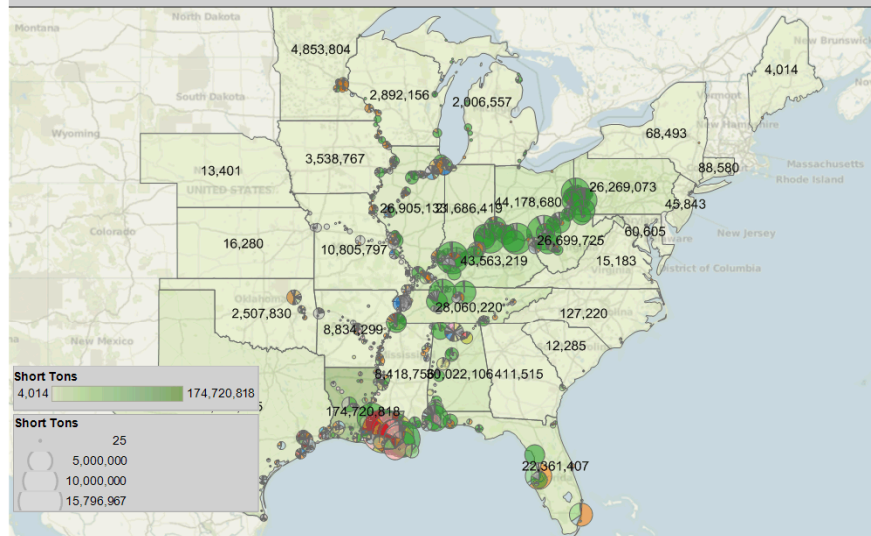
Use the filters at top right or filter by clicking on an entry in the 'TotalShipme...

ZIP Send OR Recv All

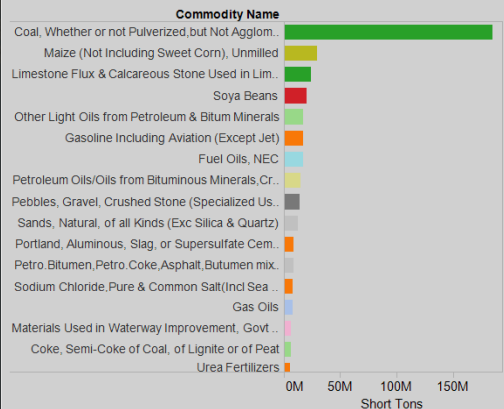
Commodity Group All

Sending or Receiving Receiving

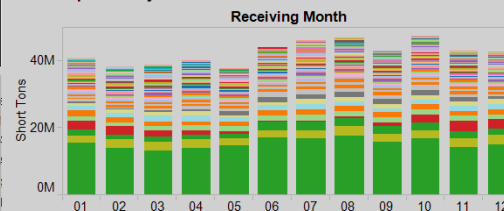
Receiving Month All



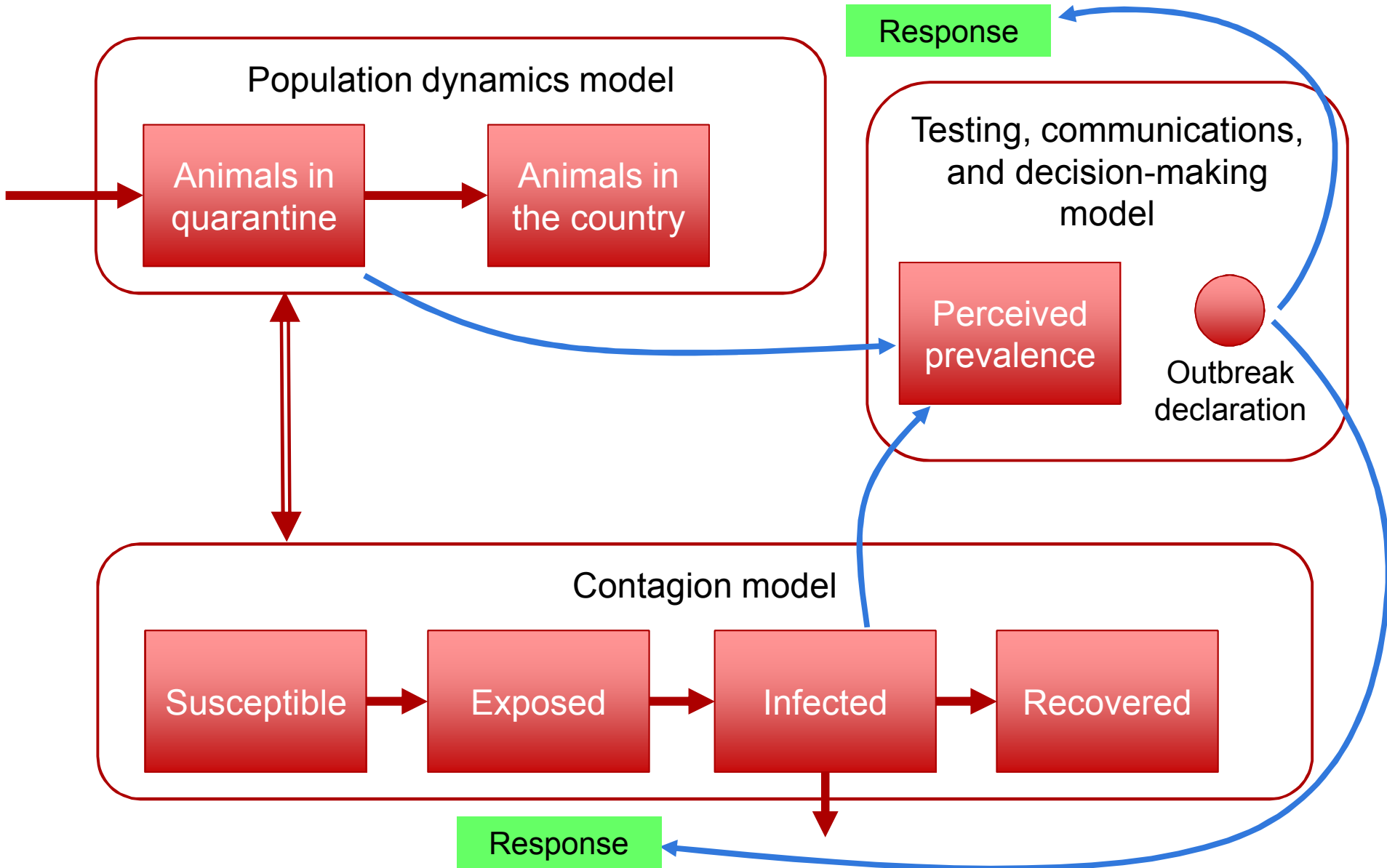
Total Shipments by Commodity



Total Shipments by Month



Example: Goats in developing nations



Given limited budget and uncertainty about the disease, should we:

Improve turnaround time for outbreak declaration

Shorter lag time between positive test and information dissemination

Improve accuracy of tests

Better sensitivity and specificity – tests have fewer false positives and false negatives

Improve quarantine and treatment facilities

Lower contact rate among goats in facilities

Secure borders

Fewer goats skirting/skipping quarantine

Lengthen mandatory quarantine

Larger facilities to handle longer residence time



Let's build a storytelling viz...

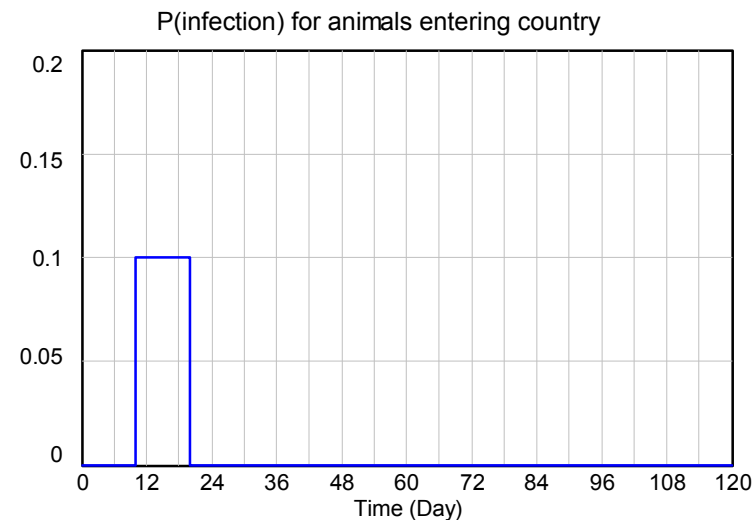
Cheers!



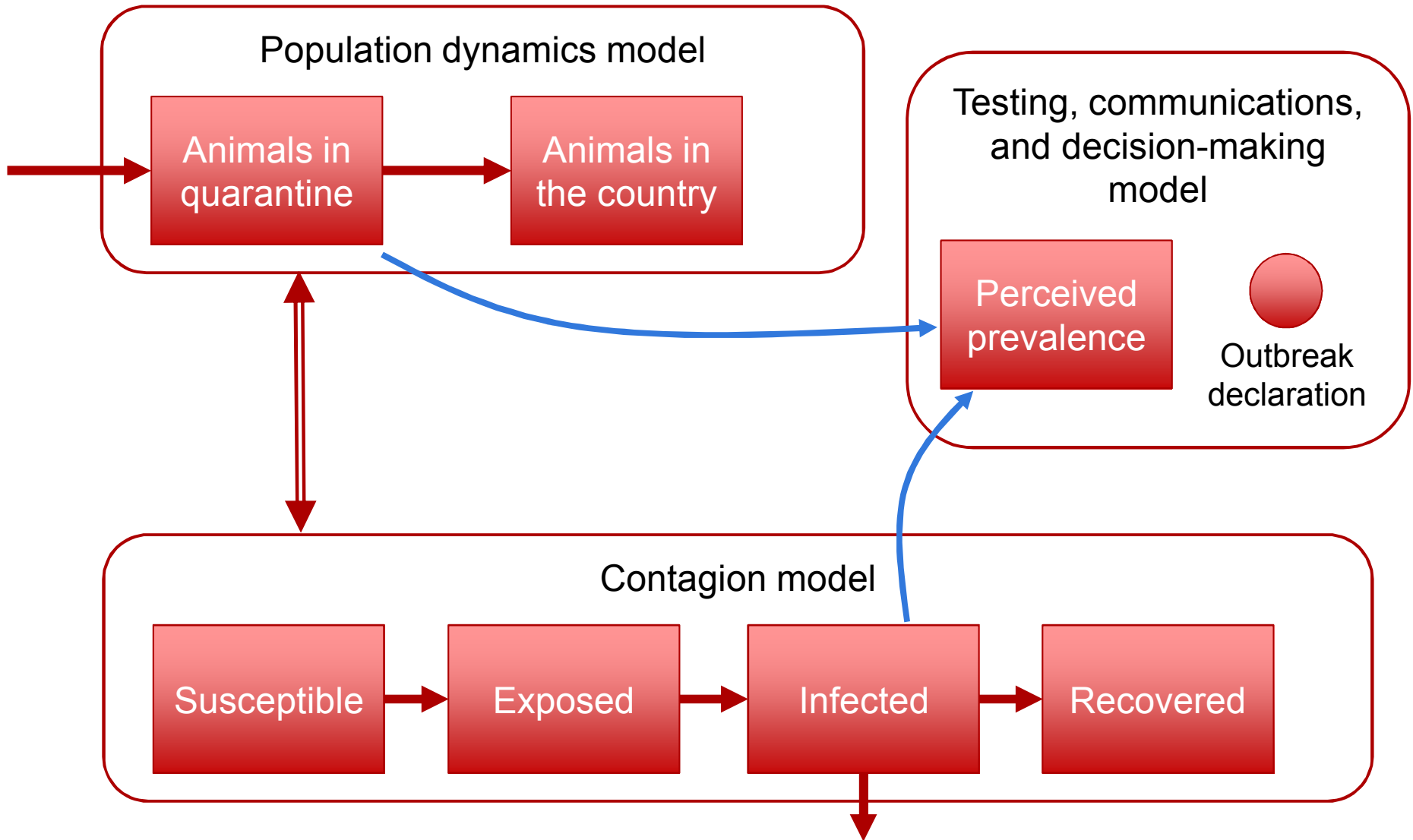
Backup

Scenario description

- Peste des petits ruminants (PPR)
 - One of the most economically important animal diseases in areas that depend on small ruminants (goats, sheep, etc)
 - High mortality (reaching >50%) and morbidity (>90%)
 - Transmission by aerosols and direct contact, potentially fomites
 - Infected animals develop discharge from eyes, nose after 4-6 days, lasting ~5 days
 - Recovered animals probably have life-long immunity
- For 10 days, 10% of incoming animals are infected with PPR

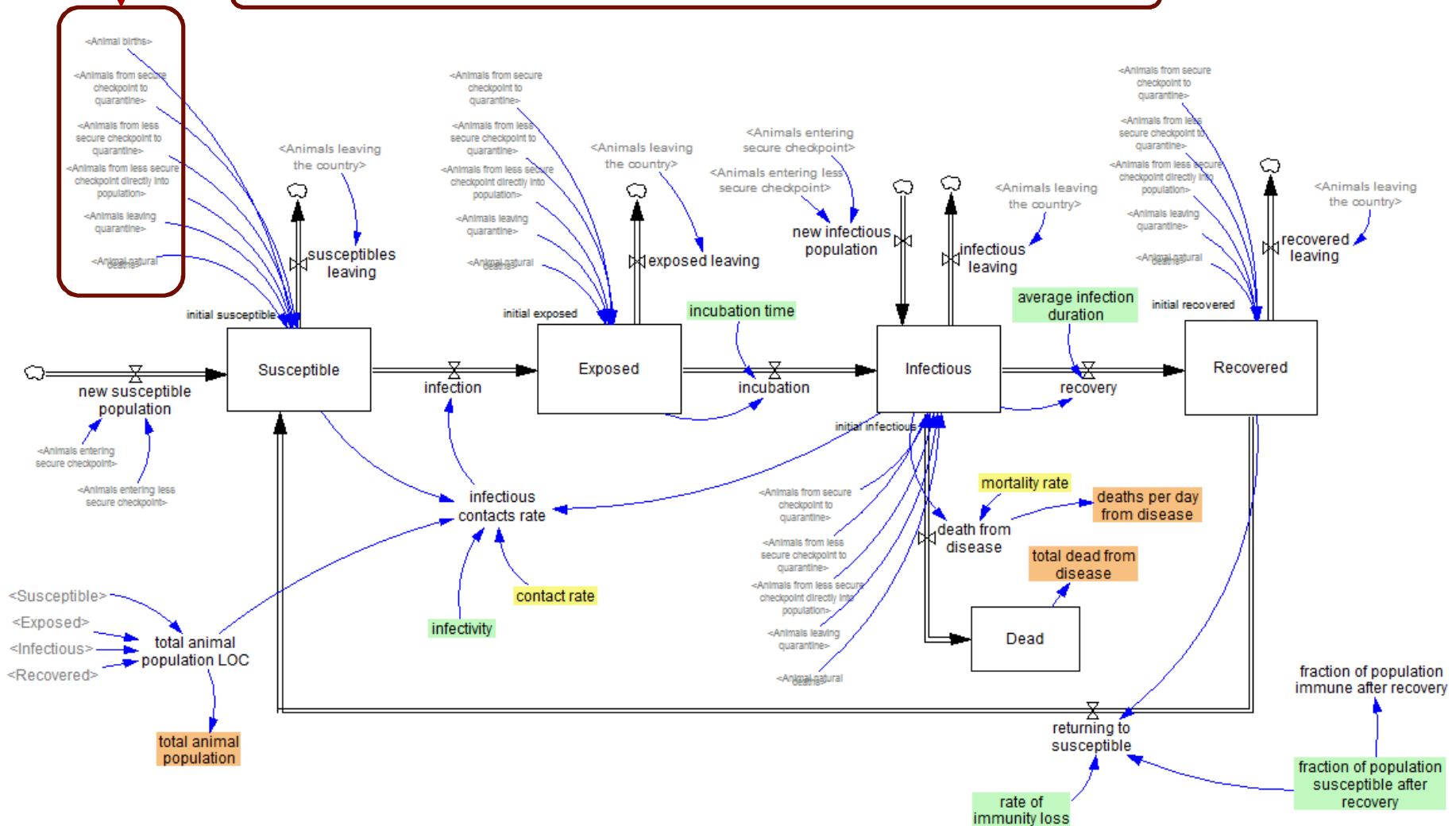


Model description



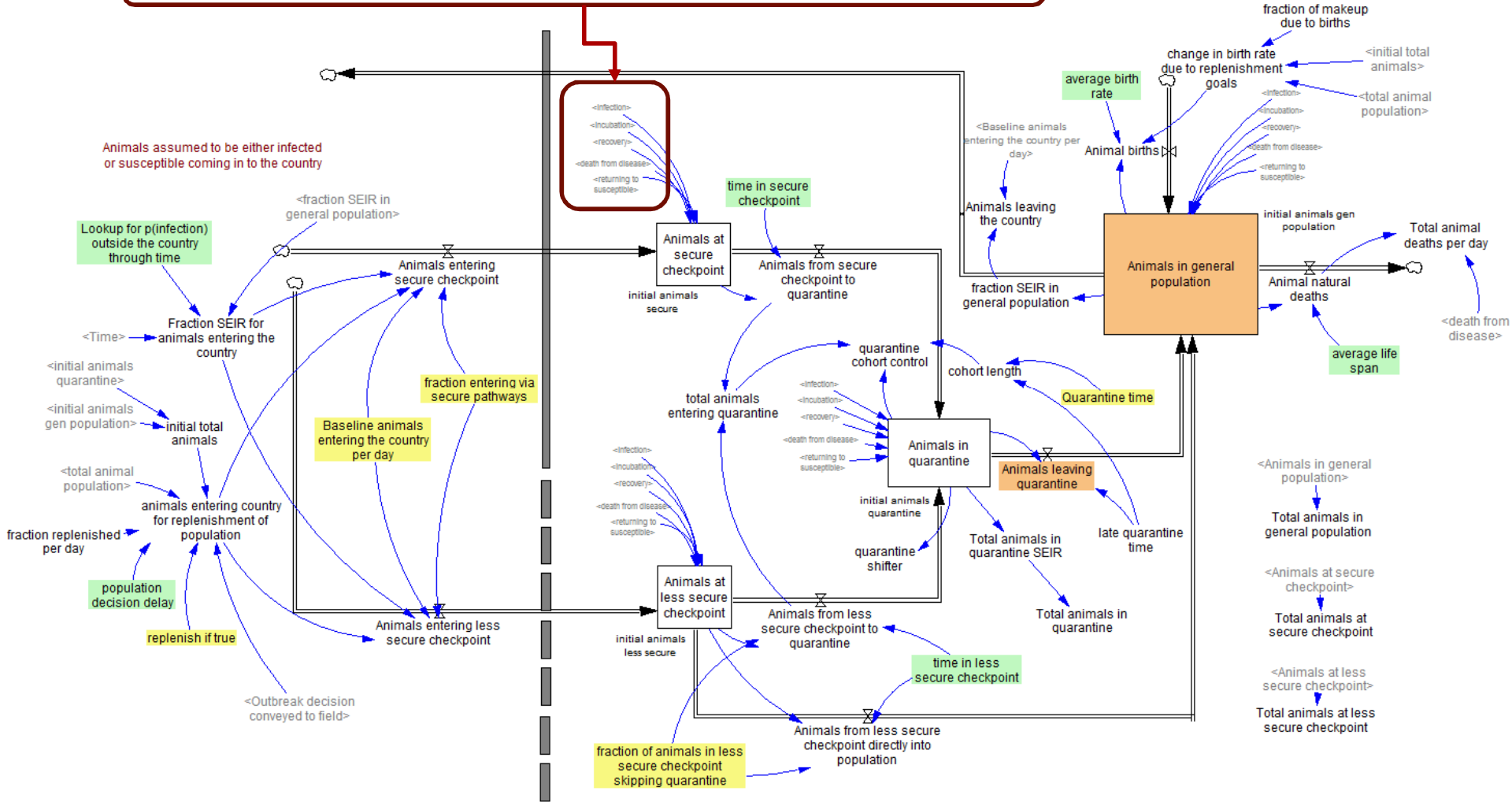
Disease epidemic model

Bringing flows from location model to SEIR model



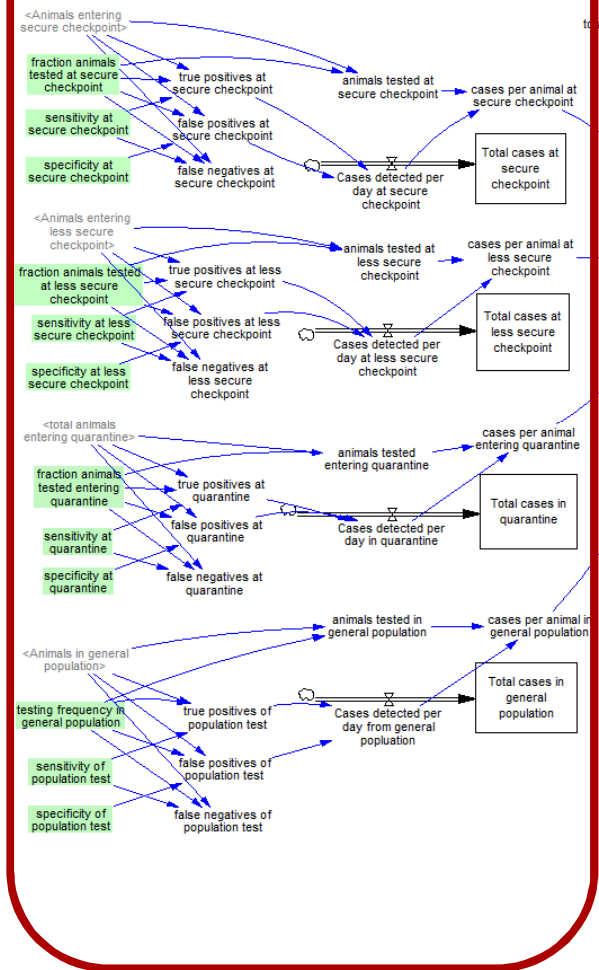
Population dynamics model

Bringing flows from SEIR model to population model

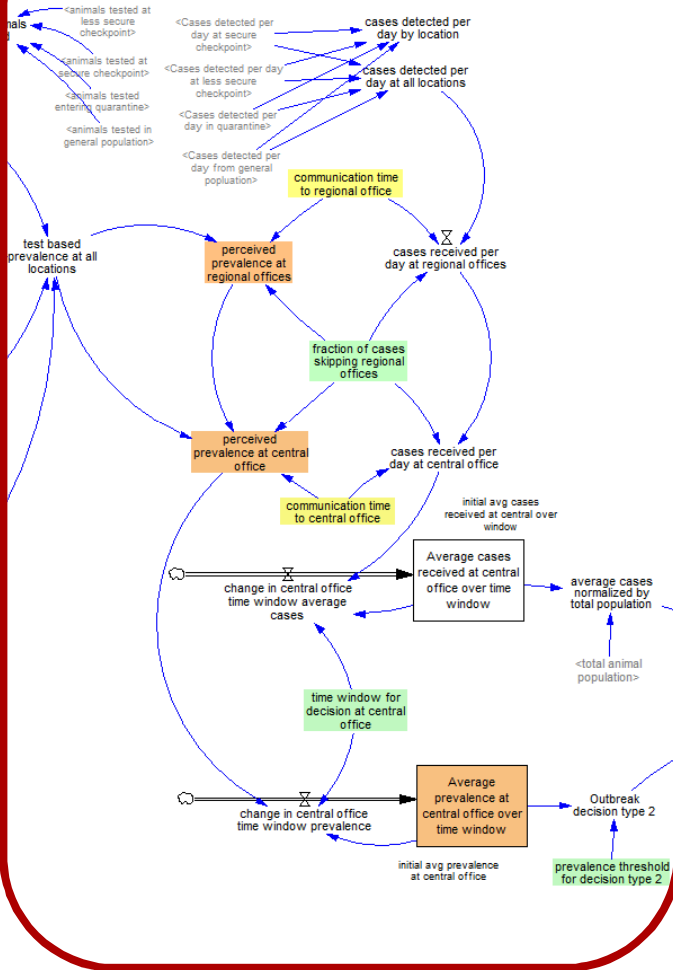


Biosecurity communication model

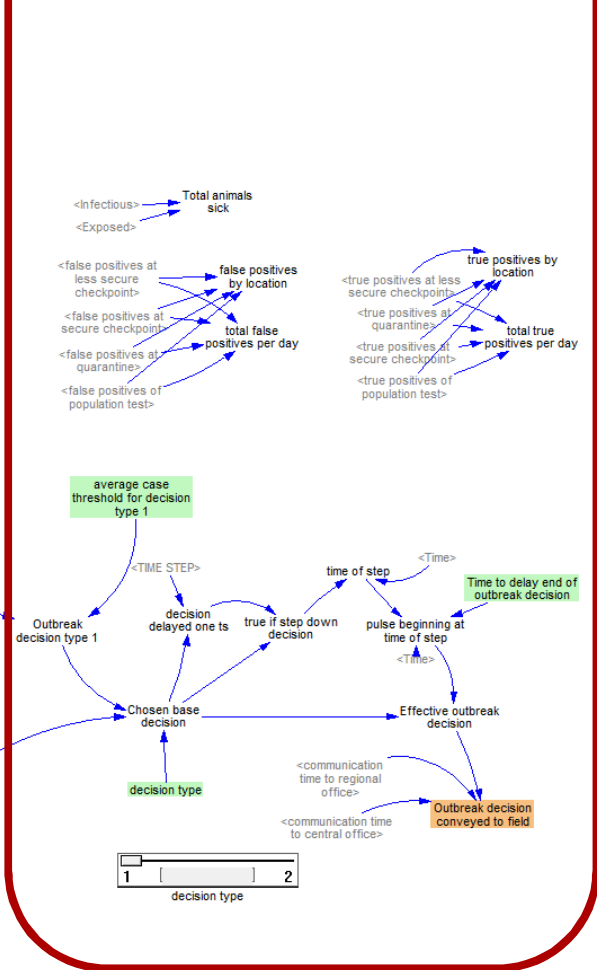
Testing



Communication

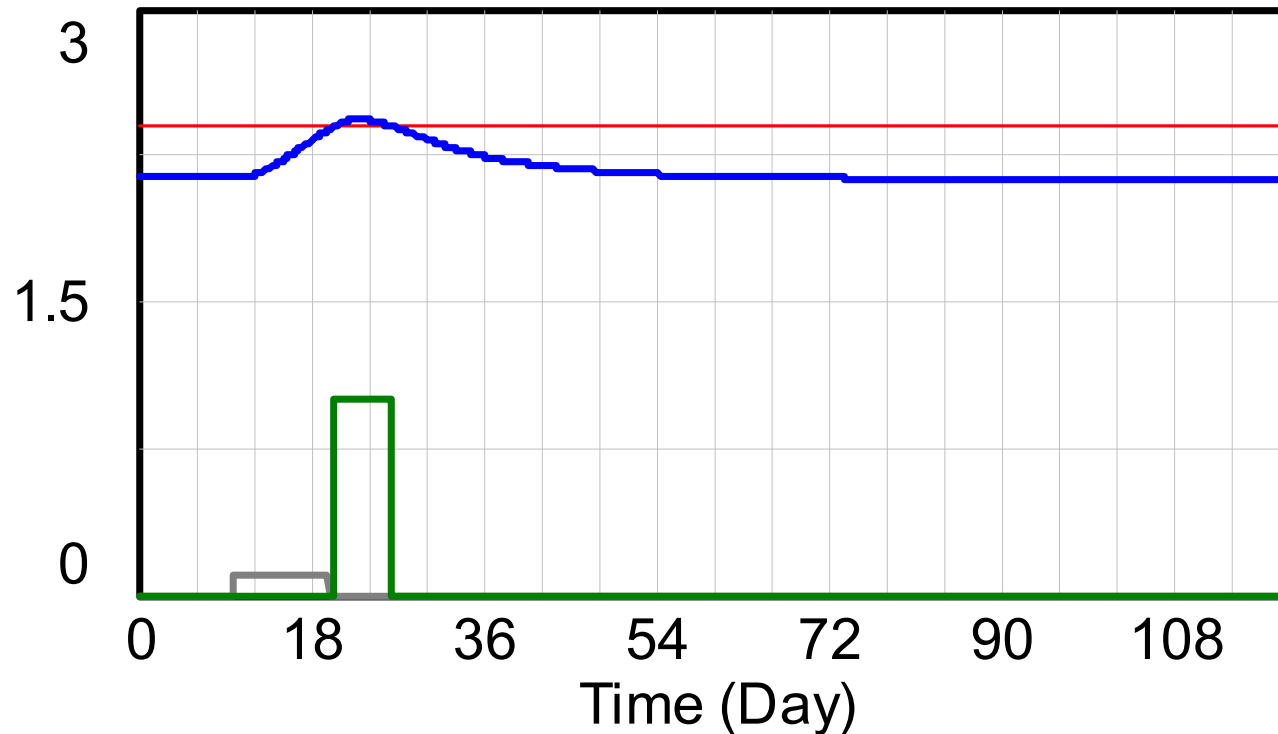



Decisions



Detection and communication description

Time windowed cases received by central office



Average cases received at central office over time window : Current 

Case threshold for decision : Current 

Decision made at central office : Current 

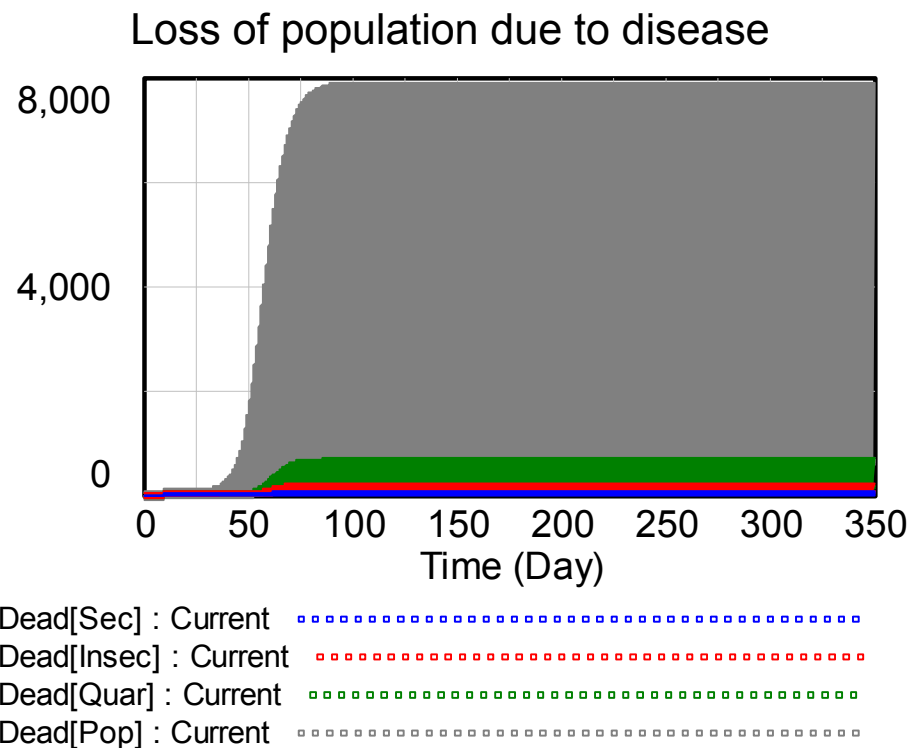
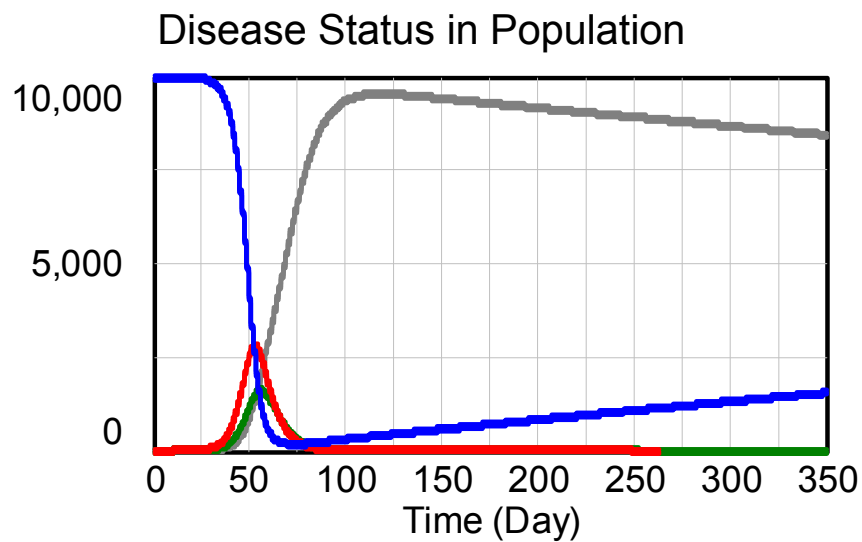
Fraction SEIR for animals entering the country[I] : Current 

Scenario: Disease Outbreak

- 10,000 animals (all susceptible) in general population
 - 10 animals per day incoming and outgoing
- 50% of animals pass through secure checkpoints
 - Good testing practices at secure checkpoints, mediocre at less secure
 - 7 day delay from testing location to central office
 - At less secure checkpoints, 50% of animals bypass quarantine
- Quarantine time = 5 days
- Disease not naturally endemic
 - Infectivity = 0.6, Contact rate [Pop] = 2.0,
 - Contact rate [Quar] = 0.2, Mortality rate = 0.2
- Baseline prevalence = 15%, outbreak declared at 18%
- No change in policies if outbreak declared

Results of the base case scenario - deaths

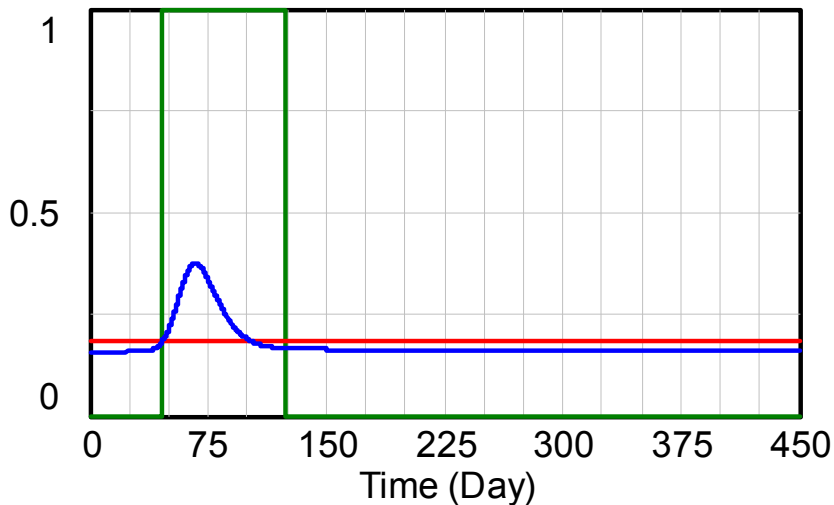
- 7,816 deaths from disease



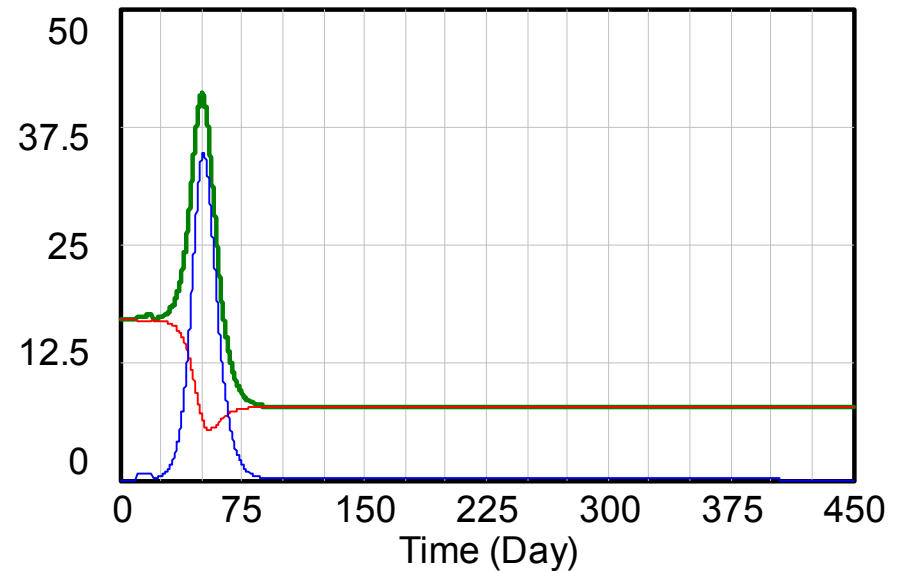
Results of the base case scenario - communication

- Initial pulse (days 10-20) not detected
- Outbreak declared on day 45
- False positives cause masking
- Central office delays “end of outbreak” decision by 20 days

Perceived prevalence at central office



Cases detected in the field per day



Options for prevention and control

- Prevention
 - Lengthen quarantine time
 - Improve quarantine facilities/procedures
 - More animals to secure checkpoints
 - Improve less secure checkpoints
 - Vaccinate
- Control and mitigation
 - Improve communication of infectious cases
 - Improve testing facilities/procedures
 - Sanitary and rapid slaughter of infected animals
 - Segregation of infectious populations from susceptible
 - Close borders during outbreak
 - Make up loss of population through births

Implementing the options

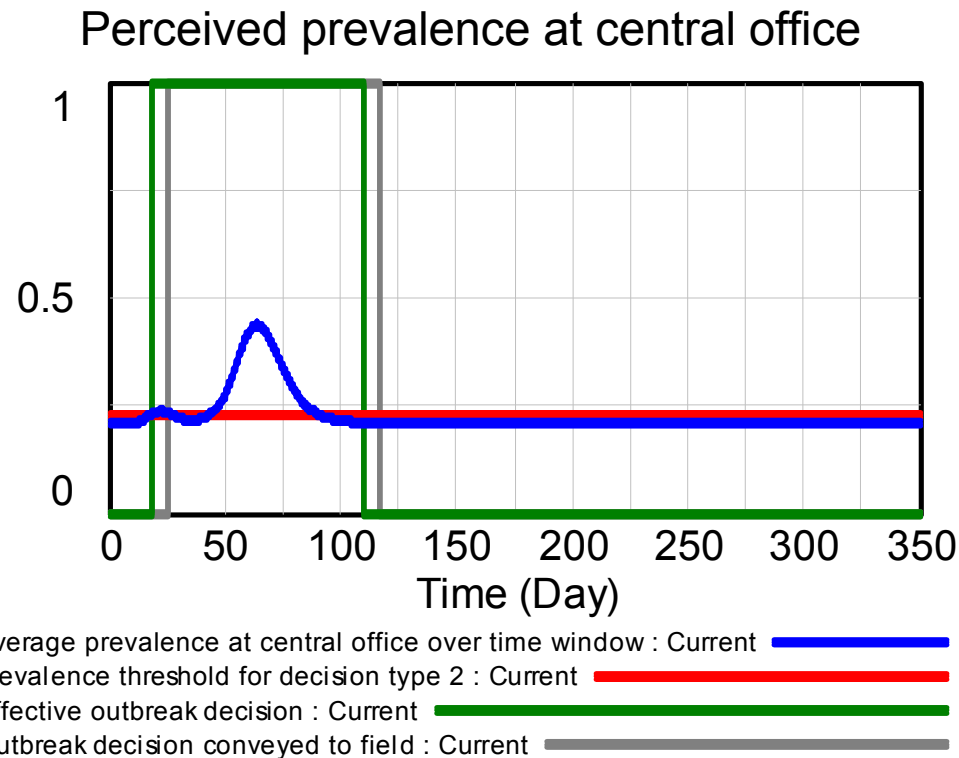
Option	Parameter	Base Value	SME Estimate
Lengthen Quarantine Time	Quarantine time	5 days	10 days
Improve quarantine facilities or procedures	Contact Rate [quarantine]	1/5 da ⁻¹	1/10 da ⁻¹
More animals to secure checkpoints	Fraction entering more secure	0.5	0.7
Improve security in less secure checkpoints	Fraction skipping quarantine	0.5	0.2
Vaccinate	Starting fraction immune	0	0.1
Improve communication of infectious cases	Total communication time	7 days	3 days
Improve testing facilities or procedures		0.75/0.85,	0.8/0.9,
Improve sensitivity/specificity across the board	Sensitivity and Specificity	0.6/0.7	0.8/0.9
Increase testing frequency in general population	Testing frequency	1% da ⁻¹	2% da ⁻¹
Close borders	Days that border can be closed	0 days	90 days

Results of individual options

Option	Total dead	Day of decision
No change	7816	54
Lengthen Quarantine Time (enlarge quarantine facilities)	7779	56
Improve quarantine facilities or procedures	7815	54
More animals to secure checkpoints	7814	56
Improve security in less secure checkpoints	7720	57
Vaccinate	6836	57
Improve communication of infectious cases	7816	47
Improve testing facilities or procedures	-	-
Improve sensitivity/specificity across the board	7816	49
Increase testing frequency in general population	7816	55
Close borders	6666	54

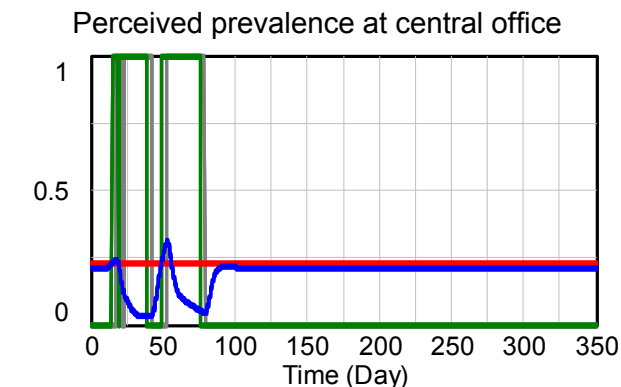
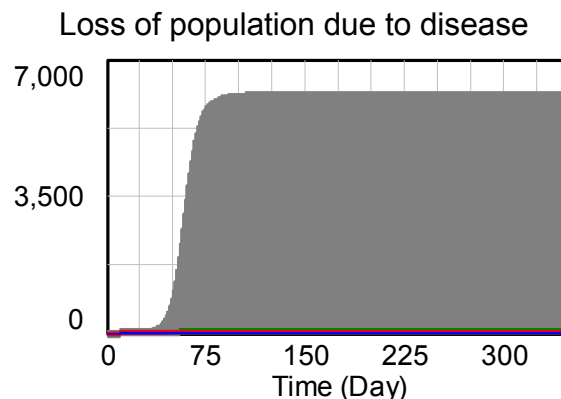
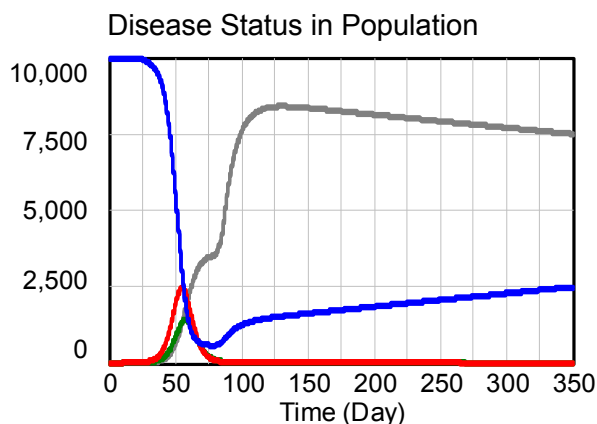
Low cost detection options

- Change weighting of tested prevalence – weight checkpoint prevalence 2x general population prevalence
- Average over a very small window, past 2 days instead of 10



Package 2: Low-cost death prevention

- Consists of
 - Employing the low-cost options
 - Close borders when outbreak declared and communicated
 - Decrease communication time from 7 to 3 days
 - Vaccinate 5% of population
- 6076 dead, detection enhanced with low-cost options and better communication – notification on day 17



Animals in general population[S] : Current —
 Animals in general population[E] : Current —
 Animals in general population[I] : Current —
 Animals in general population[R] : Current —
 Dead[Sec] : Current ⋯
 Dead[Insec] : Current ⋯
 Dead[Quar] : Current ⋯
 Dead[Pop] : Current ⋯

Average prevalence at central office overtime window : Current —
 prevalence threshold for decision type 2 : Current —
 Effective outbreak decision : Current —
 Outbreak decision conveyed to field : Current —

Discussion (making happy goats)

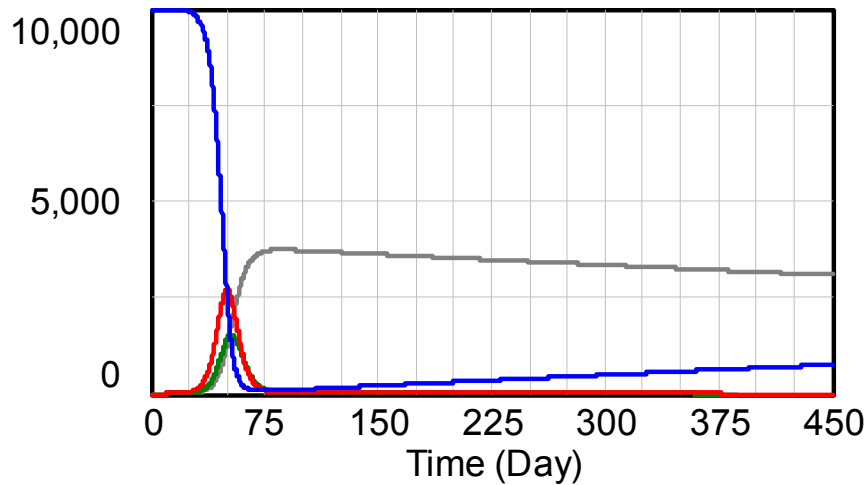
1. Where does this model succeed? What are the limitations?
2. What are the prevention/mitigation options that we didn't think of?
3. How might a model such as this be used for collaborative decision-making?







Basic Disease Outbreak

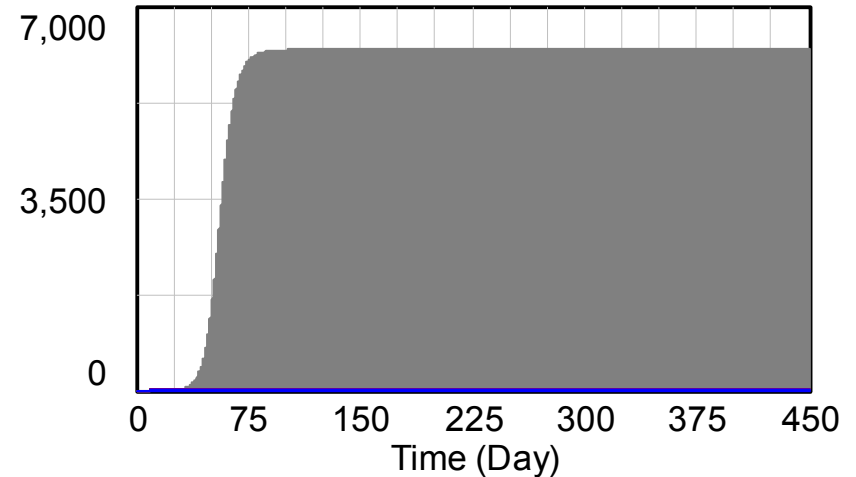
- Deaths: 6,180, mortality ~62%
- Disease burns out in general population at 80th day





Disease Status in Population



Animals in general population[S] : Current 
Animals in general population[E] : Current 
Animals in general population[I] : Current 
Animals in general population[R] : Current 

Loss of population due to disease

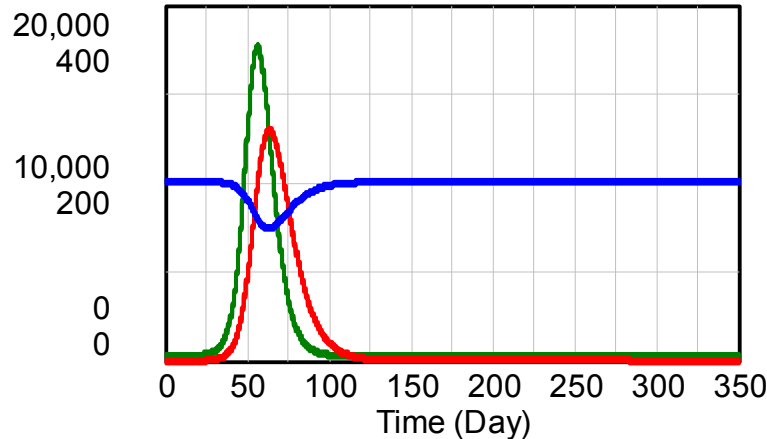


Dead[Sec] : Current 
Dead[Insec] : Current 
Dead[Quar] : Current 
Dead[Pop] : Current 

Replacements through border?

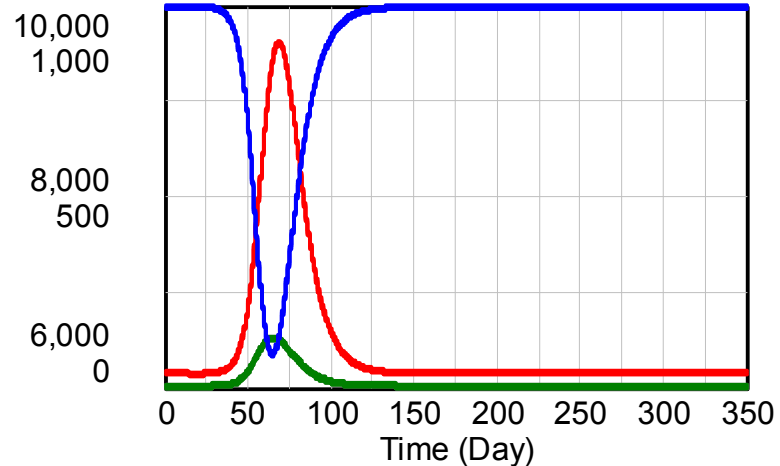
- 10% of deficit recovered through border per day
- Replacements assumed to have same SEIR fractions as general population
- Quarantine facilities need to handle 1000 animals per day – i.e. 1/10th of population is in quarantine!

Total population and replenishment



total animal population : Current —
 animals entering country for replenishment of population : Current —
 Total animal deaths per day : Current —

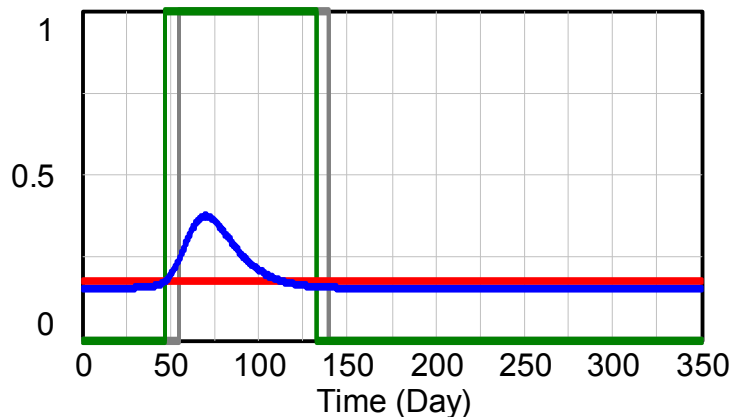
Total population by location



Total animals in general population : Current —
 Total animals in quarantine : Current —
 Total animals at secure checkpoint : Current —
 Total animals at less secure checkpoint : Current —

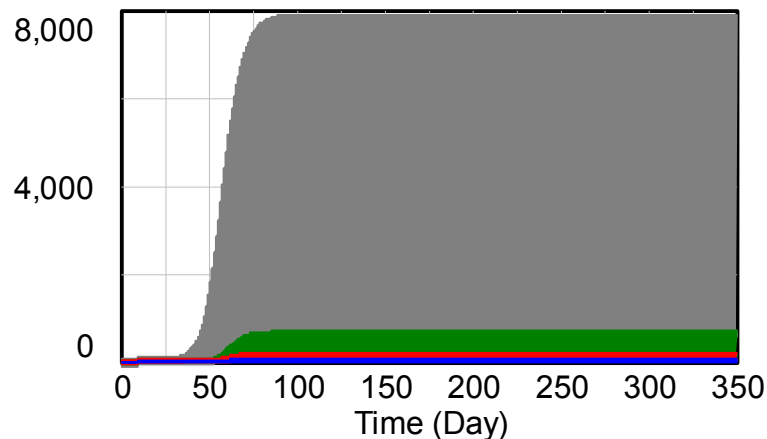
Base case with 350 day window

Perceived prevalence at central office



Average prevalence at central office over time window : Current —
 prevalence threshold for decision type 2 : Current —
 Effective outbreak decision : Current —
 Outbreak decision conveyed to field : Current —

Loss of population due to disease

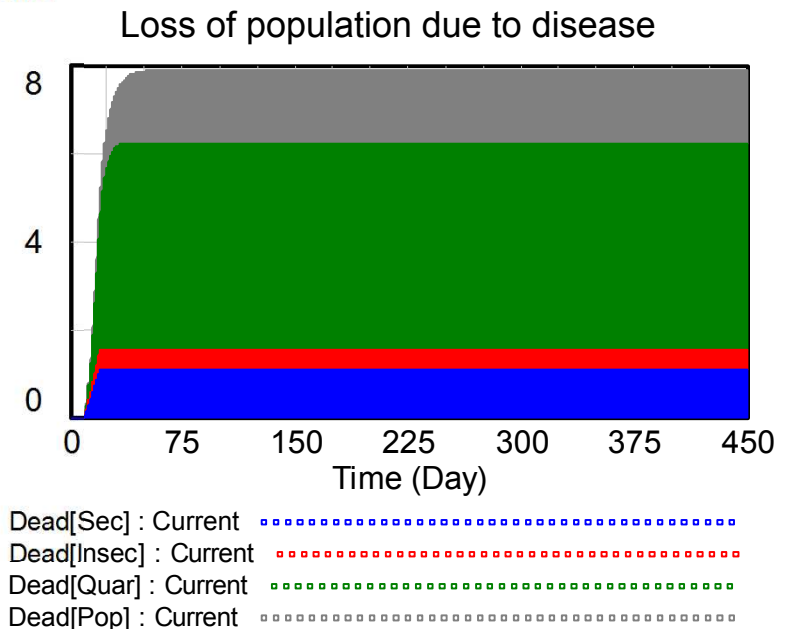
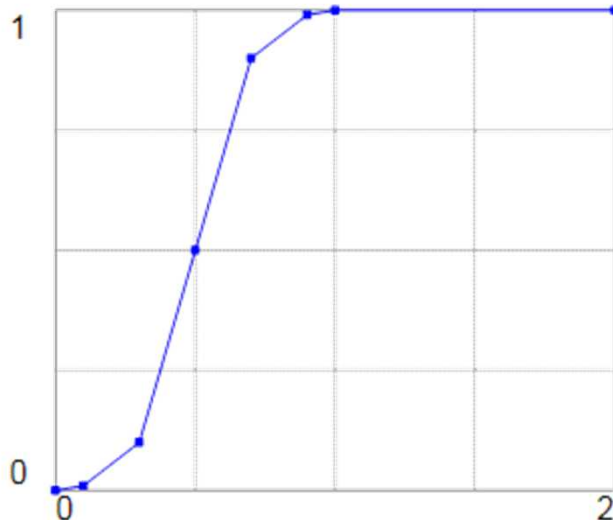


Dead[Sec] : Current ⋯
 Dead[Insec] : Current ⋯
 Dead[Quar] : Current ⋯
 Dead[Pop] : Current ⋯

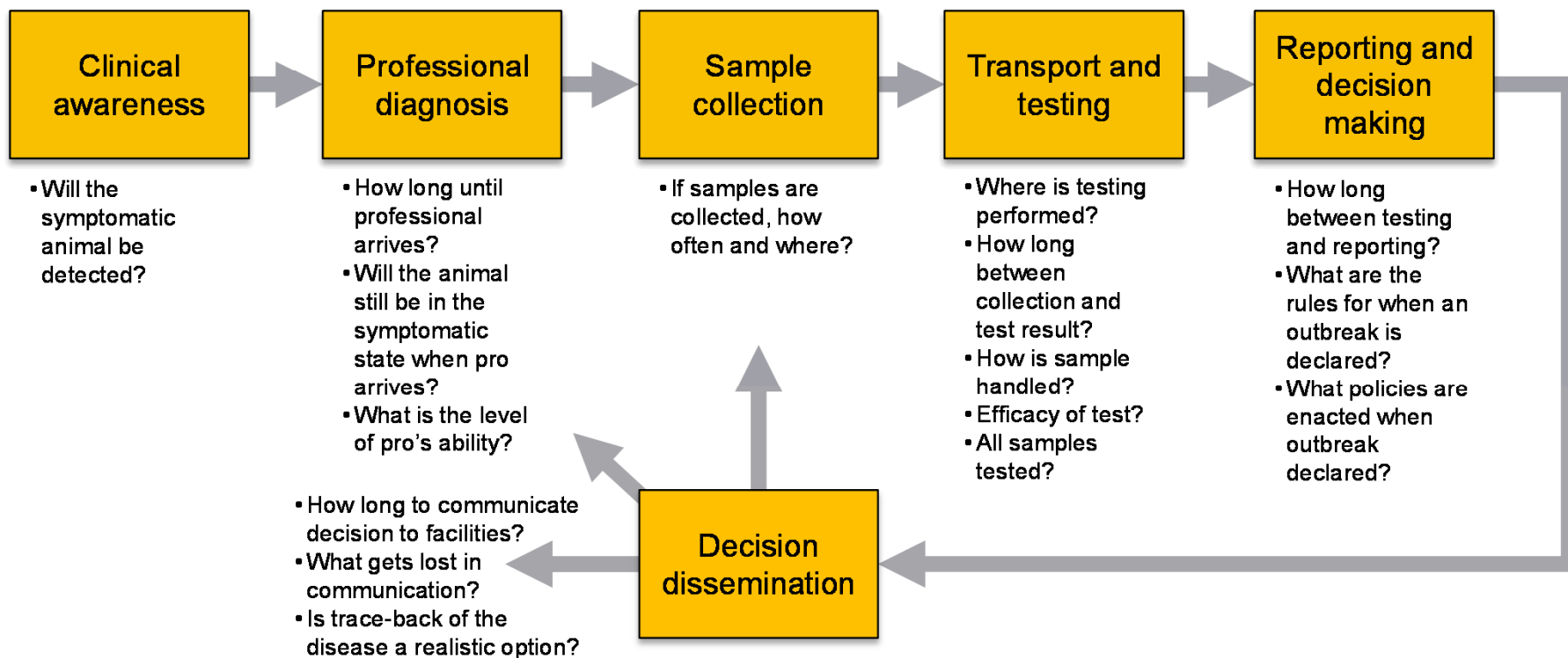
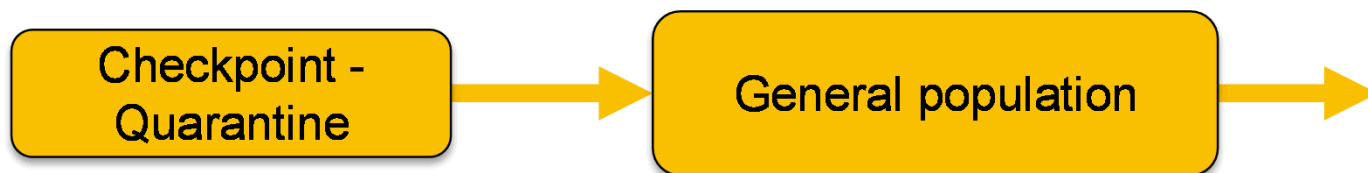
Effective mix 1: lengthen quarantine, improve quarantine procedures, secure borders, quarantine suspect populations

- Quarantine time: 5 -> 18 days
- Quarantine contact rate: 0.2 -> 0.05 per animal per day
- Fraction entering secure: 0.5 -> 0.7
- Quarantine suspect populations: off -> on

Graph Lookup - lookup for cumulative contact probability vs number infectious

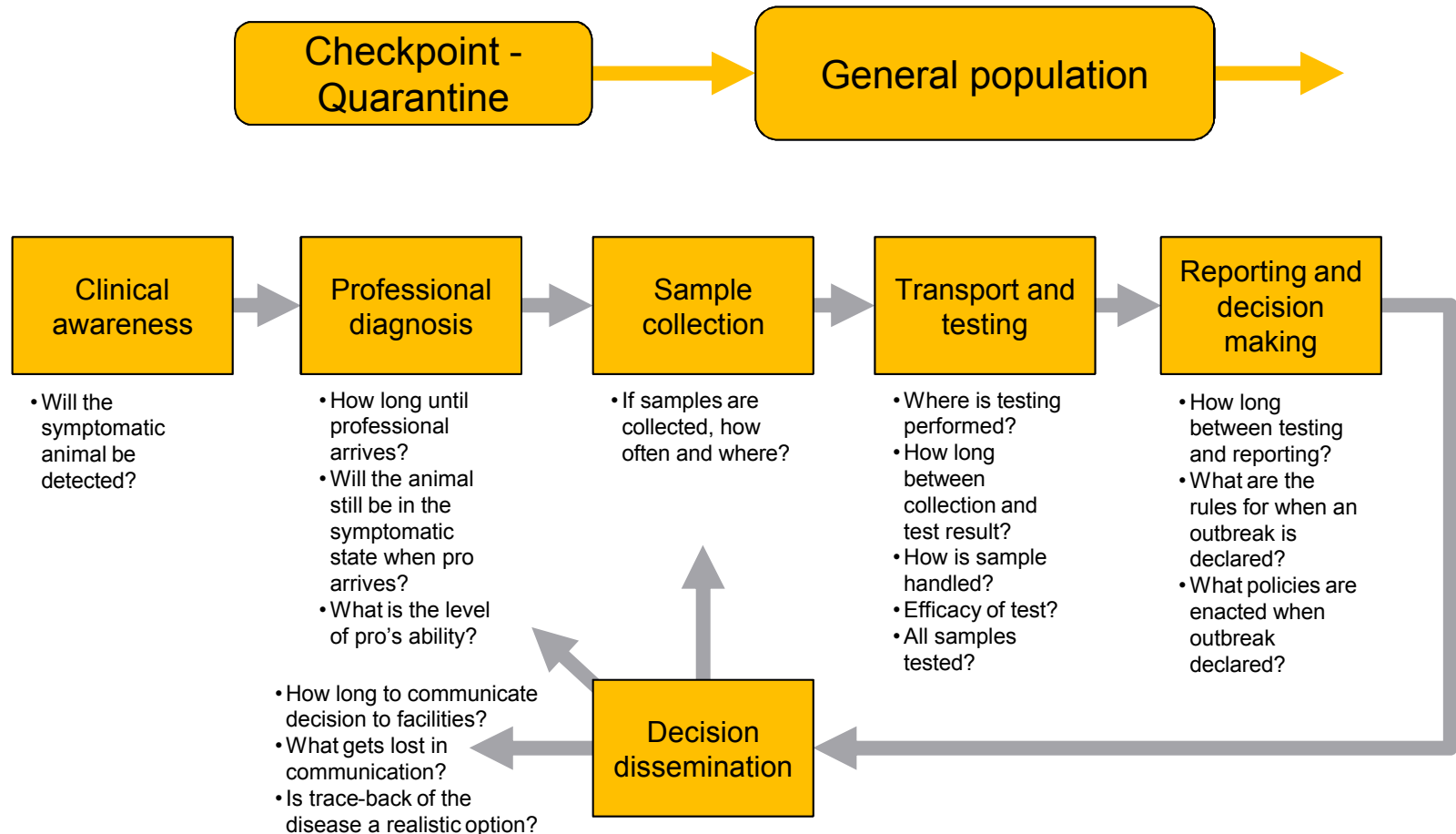


Questions at every step



Brainstorming biosurveillance model

Orange signifies flow of animals, grey flow of information



Brainstorming biosurveillance model

Orange signifies flow of animals, grey flow of information

